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# US ARMY ORDNANCE MISSILE COMMAND

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F. W. Kennell

## SATELLITE & SPACE PROGRAM PROGRESS REPORT FOR NASA

15 FEBRUARY 1959

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(NASA-CR-136028) SATELLITE AND SPACE PROGRAM Progress Report, 1-31 Jan. 1959 (Army Missile Command) 17 p LIMIT

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## SATELLITE AND SPACE PROGRAM PROGRESS REPORT FOR NASA

1-31

FOR JANUARY 1959

### FOREWORD

This is the third progress report on NASA Programs assigned to the Army Ordnance Missile Command. This report covers progress in work performed by the Army Ballistic Missile Agency and the Army Rocket and Guided Missile Agency during the period 1 January through 31 January 1959.

It should be noted that this report, prepared for NASA by the Army Ordnance Missile Command, contains financial and management information and, therefore, should not be treated as an ordinary technical report. Its use is intended only for the addressees listed.

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# ARMY BALLISTIC MISSILE AGENCY

# PROGRESS REPORT ON NASA PROGRAMS

## ABMA PROGRESS REPORT ON NASA PROGRAMS

### I. GENERAL (S)

Scheduling adjustments of NASA Requests HS-1 and HS-4 launchings, as reported last month, were satisfactorily completed, and these programs are on schedule. JUNO II launchings under NASA Request HS-21 and Project MERCURY Launchings under Requests HS-44 and HS-54 have also been incorporated into the schedule. The current ABMA/NASA tentative launching schedule may be summarized as follows:

| Vehicle | Project Request | Major Missions | Launch Date |
|---|---|---|---|
| JUNO II 14 | HS-1 | -Lunar probe: escape guidance experiment and trajectory determination by tracking. | 28 Feb-4 Mar 59 |
| *JUNO II 19A | HS-1 | -Lunar probe backup: (same as 14) | May 59 |
| JUNO II 16 | HS-1 | -Earth satellite: cosmic ray, heavy cosmic ray, Lyman-Alpha X-ray, radiation balance, and meteorite experiments. | Jun 59 |
| JUNO II 19B | HS-4 | -Earth satellite: high visibility sphere, air density experiment | Aug 59 |
| REDSTONE MR-1 | HS-44 | -Project MERCURY: flight test NASA capsule on REDSTONE booster | Oct 59 |
| JUPITER MJ-1 | HS-54 | -Project MERCURY: flight test NASA capsule on JUPITER booster | Nov 59 |
| REDSTONE MR-2 | HS-44 | -(same as MR-1) | Dec 59 |
| REDSTONE MR-3 | HS-44 | -(same as MR-1) | Jan 60 |
| JUPITER MJ-2 | HS-54 | -(same as MJ-1) | Jan 60 |
| JUNO II 19C | HS-21 | -Scientific space program: specific missions not yet assigned | Jan 60 |
| JUNO II 19D | HS-21 | -(same as 19C) | Feb 60 |
| REDSTONE MR-4 | HS-44 | -(same as MR-1) | Feb 60 |
| REDSTONE MR-5 | HS-44 | -(same as MR-1) | Mar 60 |
| JUNO II 19E | HS-21 | -(same as 19C) | Mar 60 |
| JUNO II 19F | HS-21 | -(same as 19C) | Apr 60 |
| REDSTONE MR-6 | HS-44 | -(same as MR-1) | Apr 60 |
| REDSTONE MR-7 | HS-44 | -(same as MR-1) | May 60 |
| JUNO II 19G | HS-21 | -(same as 19C) | May 60 |
| REDSTONE MR-8 | HS-44 | -(same as MR-1) | Jun 60 |
| JUNO II 19H | HS-21 | -(same as 19C) | Jul 60 |
| JUNO II 19I | HS-21 | -(same as 19C) | Sep 60 |
| JUNO II 19J | HS-21 | -(same as 19C) | Nov 60 |

*If JUNO II 14 successfully accomplishes its missions, JUNO II 19A can be made available for other space missions, and JUNO II 19B will be used for the high visibility sphere.

## II. NASA REQUEST HS-1

### A. JUNO II VEHICLE 14 (S)

1. The Vehicle 14 booster was shipped to AMR on 2 February and is currently on schedule in checkout for launching during the period 28 February - 4 March.

2. A JUNO II type shroud was modified during the month, incorporating in the top rollers which would contact the perimeter of the cluster to provide a more stable condition during spin-up. This modification will permit a desirable increase of cluster spin rate to 750 rpm. The rate used in JUNO II Vehicle 11 was approximately 400 rpm. The modifications will be installed in the Vehicle 14 shroud at AMR if all the tests currently in progress prove successful.

3. Major considerations relative to the booster operation for the forthcoming launching of JUNO II Vehicle 14 are summarized for general information in the following paragraphs. The payload is a Jet Propulsion Laboratory (JPL) responsibility.

a. Mission:

The mission of JUNO II Vehicle 14 is to accomplish an escape guidance experiment and determine the trajectory of the 15 pound payload in its path toward the moon. The JPL payload will carry a cosmic ray counter, a trackable beacon, and an optical device for determining payload location in space relative to the moon. This payload is essentially the same as the one carried by JUNO II Vehicle 11; it weighs .5 pound more.

b. Booster:

(1) 1st stage: This is a JUPITER booster with propellant tanks increased 36 inches in length. Its NAA S-3D engine is rated at 150,000 pounds thrust at sea-level and utilizes RP-1 fuel and liquid oxygen as propellants. The extended tankage allows a maximum burning time of 185 seconds; normal JUPITER Missile burning time is approximately 160 seconds.

(2) Upper stages: The second, third and fourth stages are built by JPL. The stages consist of a cluster of 11 solid propellant motors with an Isp. of 219.8 sec., a cluster of 3 solid propellant motors with an Isp. of 236 sec., and a single solid propellant motor with an Isp. of 249 sec. The fourth stage has a Titanium motor case, which is 2 pounds lighter than a standard alloy case.

c. Shroud:

The shroud is a metal housing, coated with a special

insulative resin, which envelopes the upper stages and payload and protects the payload and clusters against aerodynamic heating and stresses encountered during flight through the sensible atmosphere. The shroud supports a boom-type angle-of-attack meter for stabilization control under aerodynamic forces such as shear winds. The conical portion of the shroud is separated by means of explosive bolts and springs, approximately 17 seconds after the top section has separated from the booster. The conical portion is pushed out of the path of the clusters by a lateral thrust rocket.

d. Flight mechanics:

(1) Launch Site: Atlantic Missile Range

(2) Firing Azimuth: $79^{o}$ to $97^{o}$

(3) First Stage Control: Same as JUPITER with the following exceptions:

(a) Velocity guidance is used in the cross-range and slant-altitude directions.

(b) A velocity guidance computer will be used.

(c) Coordinate resolvers will be placed in the slant-range and slant-altitude circuits to provide two additional cut-off angles for the slant-range axis.

(d) A vernier motor will not be used.

(e) Only two pre-settings will be used (slant range velocity and a constant term to account for spatial attitude control of the body after separation from the booster).

(f) A boom type angle-of-attack meter will be used.

(g) Proportional jet nozzles will be used for spatial attitude control.

(h) Retro-rockets on the tail of the booster will assure a clean separation and minimize the danger of bumping between booster and instrument compartment.

(4) Upper Stage Control: Attitude control is obtained by spinning the cluster. Tests are being conducted to determine the feasibility of a 750 rpm spin rate with a shroud modification. (See above, Par II A2.) The second stage is fired by a timer in the instrument compartment which is triggered by the engine cut-off signal. The third and fourth stages are fired at intervals

[redacted]

of 8.5 seconds by a timer inside the third stage.

(5) Payload De-spin: The payload spin rate is reduced to approximately 6 rpm around 8 hours after launch. The "de-spin" device consists of two small weights, attached to wires on opposite sides of the payload. The wires are wrapped around the exterior of the payload. The signal for release of the weights is given by a hydraulic timer, set two hours before launch. As the weights are unwound by centrifugal force, a major portion of the angular momentum will be transferred to them. Then, when released, the weights carry that portion of the momentum away, and the spin of the payload is reduced to the proper rate. The amount of "de-spin" is governed by size of the weights and length of the wires.

e. Trajectory:

1. The aiming azimuth and pitch program are dependent on the date and time of launch. Deviation of launch time will be restricted to ±5 minutes from zero time. Zero times will be precalculated to enable quick change of upper-stage pitch program and vehicle launch azimuth.

2. In general, the vehicle will follow an accelerated pitch program which carries the missile through the sensible atmosphere for an extended period of the initial trajectory. This places comparatively severe heat resistance requirements on the shroud. Booster cut-off, which is functional, occurs when the proper velocity and attitude relative to the local vertical are attained. Separation of the aft section and upper stages from the booster takes place 6 seconds after cut-off. The instrument compartment with the mounted clusters then coasts for approximately 60 additional seconds to allow for further escape from the Earth's denser atmosphere to the less dense atmosphere encountered at the higher altitudes, thereby avoiding excessive aerodynamic heating of clusters when fired. The coast period also allows for attitude stabilization of the instrument compartment after separation. The payload will follow a hyperbolic trajectory toward the moon, requiring approximately 34 hours for intercept.

B. <u>JUNO II VEHICLE 16</u> (S)

1. <u>Booster</u>

The JUNO II Vehicle 16 booster is on schedule in fabrication at ABMA.

2. <u>Upper Stages</u>

The Vehicle 16 upper stages being manufactured by JPL remain on schedule.



[redacted]

3. Payload (See Figs. 1 & 2)

a. With the decision during January to include the LaGow special meteorite experiment in the payload of Vehicle 16, the objectives of this satellite may be summarized as follows:

(1) The Van Allen cosmic ray intensity experiment will obtain data on cosmic ray intensities above the atmosphere on a comprehensive temporal and geographical basis. Detectors used are geiger tube and scintillator types.

(2) The Friedman Lyman-Alpha and Solar X-radiation experiment will determine the effects of solar radiations on the terrestial atmosphere. Three detectors are to be used: Two Lyman-Alpha ionization chambers, and one solar photocell.

(3) The Groetzinger heavy cosmic ray experiment will determine the flux of heavy cosmic ray primaries of atomic number greater than seven. The ionization chamber applied to detect these particles is an instrument for determining the ionization per-unit-path-length generated whenever a charged particle passes through argon gas, with which the chamber is filled.

(4) The Suomi radiation balance experiment will determine with reasonable accuracy the daily value of the input to the atmospheric heat engine. Hemispherical sensors (thermistors) attached to the surface of the satellite, are used to measure temperature as a function of orbit position. The experiment requires use of a data storage system.

(5) The LaGow micro-meteorite experiment was added in January. This experiment will determine the number and sizes of meteorites encountered by the payload. Telemetering channels for this experiment were added to the 108 mc transmitter.

b. The overall payload configuration and weight remains the same, a double cone with a center ring, weighing about 80 pounds. The majority of the components for the five experiments are contained in a cylindrical section in the middle of the payload. The overall dimensions of the payload are: diameter approximately 30 inches; length 30 inches.

c. The payload will transmit at frequencies of 20 mc and 108 mc. The 108 mc frequency will be utilized for tracking purposes. A wire antenna of 24 ft. total length, unreeled from a motor driven drum located on the spin axis of the payload, will transmit the 20 mc signal. Mercury batteries with a lifetime of approximately two months will provide power for the tracking transmitter. The remaining power requirements will be fulfilled by nickel-cadmium batteries charged by solar cell pads mounted above and below the

center ring of the payload. Charging takes place while the payload is passing through sunlight.

4. Status of Payload Fabrication and Design

a. Considerable modification of design was made necessary for incorporation of the LaGow micro-meteorite experiment in the payload. Design modifications necessary to mount the three sensors for this experiment on the center ring, changes in battery boxes and supports, addition of wiring terminal blocks, and additional reinforcement of the structure were completed and fabrication is underway. As a result of these changes assembly work was halted on payload #2 until these modified parts are manufactured and available. Modifications to prototype payload #1 were so extensive that it was decided to fabricate a third payload identical to #2. Payload #1 will be used for preliminary antenna measurements. In order to expedite testing, payloads #2 and #3 will be used interchangeably for extensive environmental and RF and telemetering tests.

b. Other modifications to make available 4 additional telemeter channels for the micro-meteorite experiment were initiated.

c. The telemetry approach used for incorporating the micro-meteorite experiment requires a six-channel resistance multiplexer working into a resistance controlled subcarrier oscillator which phase-modulates the tracking transmitter. The electronics, including the tracking transmitter for this telemetering, were built on a single printed circuit board measuring five inches in diameter by one inch thick. NASA personnel were briefed on this approach and expressed satisfaction with the design. At the close of this reporting period, the designs have been completed, five multiplexers and subcarrier oscillators have been assembled on printed circuit boards, and final testing of these units has begun. Delivery of these units is expected to be made on schedule.

d. Development of the antennas for this satellite is continuing. Modification of the 108 mc antennas in an effort to obtain a more favorable impedance is being made. The testing of the 20 mc antenna under vacuum and spin conditions was begun. These tests will involve the complete operation of the system. However, physical size of the vacuum chamber will limit release of the wire to only 5 ft. rather than the designed 12 ft. A possible redesign may be necessary on the slip rings within the 20 mc antenna system to lower the capacitance between the slip rings and antenna spool. The design change is being investigated.

e. Two sets of prototype modules for temperature measurements on Vehicle 16 payload and one set of prototype sensing organs were received from the University of Wisconsin and checked out in the laboratory.

f. Ten tests have been performed on M1A1 squibs with housings as a possible means of separating the payload from the fourth stage motor. All tests were successful.

g. A rocket propelled sled will be used for structural testing of payload 16 under spin and linear acceleration of 35 g. ABMA is designing all mechanical equipment including a test payload. Army Rocket and Guided Missile Agency (ARGMA) is designing the sled structure and measuring equipment. ABMA will fabricate the sled and mechanical test equipment including spin-up device. The mechanical design of all necessary equipment has been completed and fabrication is in progress. The on-board measuring system has been finalized and necessary equipment is being assembled.

C. JUNO II VEHICLE 19A (S)

1. The Vehicle 19A booster, being prepared as a backup for Vehicle 14, is on schedule in assembly at ABMA.

2. Application of the heat protective coating to the aft section skin has been completed. The material used is CTL-803, a phenolic resin reinforced with mica. The entire aft section was preheated in a special furnace to 180°F, sprayed with the coating and allowed to cure until dry. This process was continuously repeated until the desired thickness of the coating was obtained (about .065 inch).

3. The spin-launcher for 19A was modified for high speed drive (750 rpm) and delivered to JPL for mating with the upper stages.

III. NASA REQUEST HS-4 (C)

The JUNO II Vehicle 19B booster, scheduled to launch a high visibility sphere payload of approximately 26 pounds, is on schedule in fabrication at ABMA.

IV. NASA REQUEST HS-21 (S)

A. The eight JUNO II vehicles to be produced under this request are identified as JUNO II Vehicles 19C, 19D, 19E, 19F, 19G, 19H, 19I, and 19J. These vehicles will in general be identical to the JUNO II Vehicles 19A and 19B. They have no specific missions assigned but can be readily adapted to launch either Earth satellites or space probes. A NASA/ABMA conference to establish basic payload parameters is scheduled for mid-February at ABMA.

B. The possibility of using the JPL Starfinder upper stage for some of these vehicles has been eliminated by NASA direction. Standard JUNO II solid propellant clusters will be used for all eight vehicles.

C. The feasibility of using body-fixed control accelerometers on

JUNO II Vehicles appears practical from the control and bending stability standpoints.

D. Fabrication of Vehicles 19C and 19D has begun on schedule.

V. <u>NASA REQUEST HS-44</u> (S)

A. The eight REDSTONE Mercury boosters to be furnished under this request are identified as MR-1, MR-2, MR-3, MR-4, MR-5, MR-6, MR-7, and MR-8.

B. Calculation of mass characteristics, weight, center of gravity and moment-of-inertia information for the MR-type vehicle was begun on schedule.

C. A change in the REDSTONE instrument compartment configuration for Mercury application necessitated some changes in the instrument group. Three different approaches are being considered for the instrument group assembly. Layouts are nearing completion.

D. The standard cooling system cannot be used with the changed instrument group arrangement. Consequently, work has begun on designing a new cable-mast-mounted cooling system which utilizes $LN_2$ for a coolant.

E. Preliminary stress and dimension calculations for the instrument compartment have been made. Skin thickness, bulkhead thickness, ring frame dimensions and locations, and access door frame dimensions and locations have all been fixed. Final stress analysis must be accomplished prior to approval. Progress in this project is on schedule.

F. Preparations are being made to secure acoustical measurements on at least two REDSTONE missile flights in the current Engineer-User Test series. These data are needed for the Mercury program.

G. Preliminary maximum in-flight shear forces, bending moments, and longitudinal forces were determined for the REDSTONE MR vehicle with an estimated lift-off weight of 64,000 pounds. The maximum longitudinal acceleration will be 4.94 g.

H. Wind tunnel tests on REDSTONE Mercury booster models at ABMA have been completed; plans have been made for additional tests in NASA facilities. These tests will provide further information on static stability derivatives at transonic Mach numbers and will determine the effects of Reynolds number at supersonic Mach numbers. The test models are scheduled to be delivered to NASA by 15 February 1959.

I. The trajectory shaping problem for the REDSTONE Mercury booster calls for a compromise among the requirements of (1) longest

possible flight without inertial load, (2) limited drag loads in dive and (3) highest possible aerodynamic stability of the total missile in the propulsion phase. This problem has been solved. The solution assumes a deadweight addition of 1,500 pounds in the nose of the vehicle, a complete loading of propellants, and near maximum burning time. The resulting trajectory covers a range of 135 nm. and reaches a summit altitude of 173 kilometers. When applied to AMR, the terminal point of the trajectory would be in the Little Bahama Bank. The time of free flight is 4.7 minutes and the maximum drag deceleration is near 9 g's.

J. Advance electrical component charts were released for Missiles MR-1 and MR-2.

K. Ground and missile network design is in progress.

VI. <u>NASA REQUEST HS-54</u> (S) (See Fig. 3)

A. The two JUPITER boosters to be furnished under this request for use in Project Mercury are identified as MJ-1 and MJ-2. Design work was begun on schedule, and fabrication of MJ-1 has begun.

B. Calculation of preliminary weight, center-of-gravity, and moment of inertia information for Vehicle MJ-1 was begun. An adapter, 27.75 inches in length has been designed for mounting the capsule to the top of the JUPITER aft section. Initial layouts of the Mercury capsule on the JUPITER have been made.

VII. <u>NASA REQUEST HS-20</u> (U)

NASA Request HS-20, dated 19 January 1959, requests that ABMA support JPL in its Space Flight Program Study. Work under this request has been initiated.

VIII. <u>FUNDING STATUS</u> (U)

Status of funds for work on NASA Requests being conducted by ABMA is tabulated in Appendix I.

[redacted]

**STATUS OF FUNDS**
As of 31 January 1959
(millions of dollars)

| NASA Requests | Funding Method | Dollar Value of Order | Dollar Value Orders Placed (1) | Dollar Value of Deliveries (2) | Dollar Value of Billings |
|---|---|---|---|---|---|
| HS-1 | Reimbursement | 20.930 | 17.405<br>(14.500) | 10.161 | 4.380 |
| HS-4 | Reimbursement | 2.154 | 1.645<br>(1.364) | .375 | .021 |
| HS-21 | Reimbursement | 8.540 | 4.157<br>( .881) | .075 | 0 |
| HS-44 | Reimbursement | 4.490 | 1.335<br>( .170) | .100 | .010 |
| HS-54 | Reimbursement | 2.742 | 0 | 0 | 0 |
| HS-20 | Reimbursement | .337 | 0 | 0 | 0 |

(1) Value of Orders Placed Expressed as Program Orders Issued and (Finalized)

(2) Value of Deliveries is Estimated Expenditures Since Accurate up-to-date R&D,A Expenditures are not Available at this time.

Appendix I



[redacted]

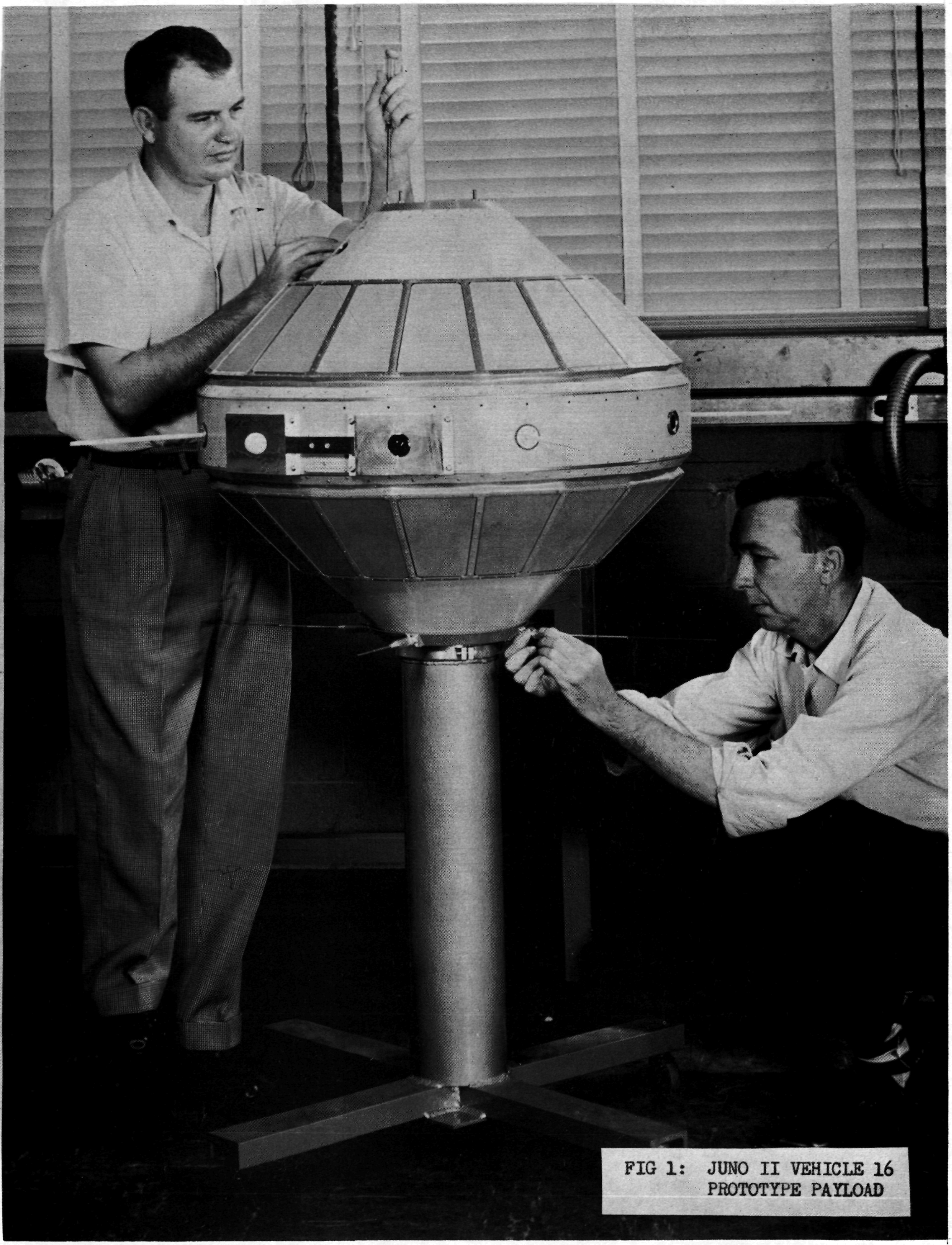


FIG 1: JUNO II VEHICLE 16
PROTOTYPE PAYLOAD

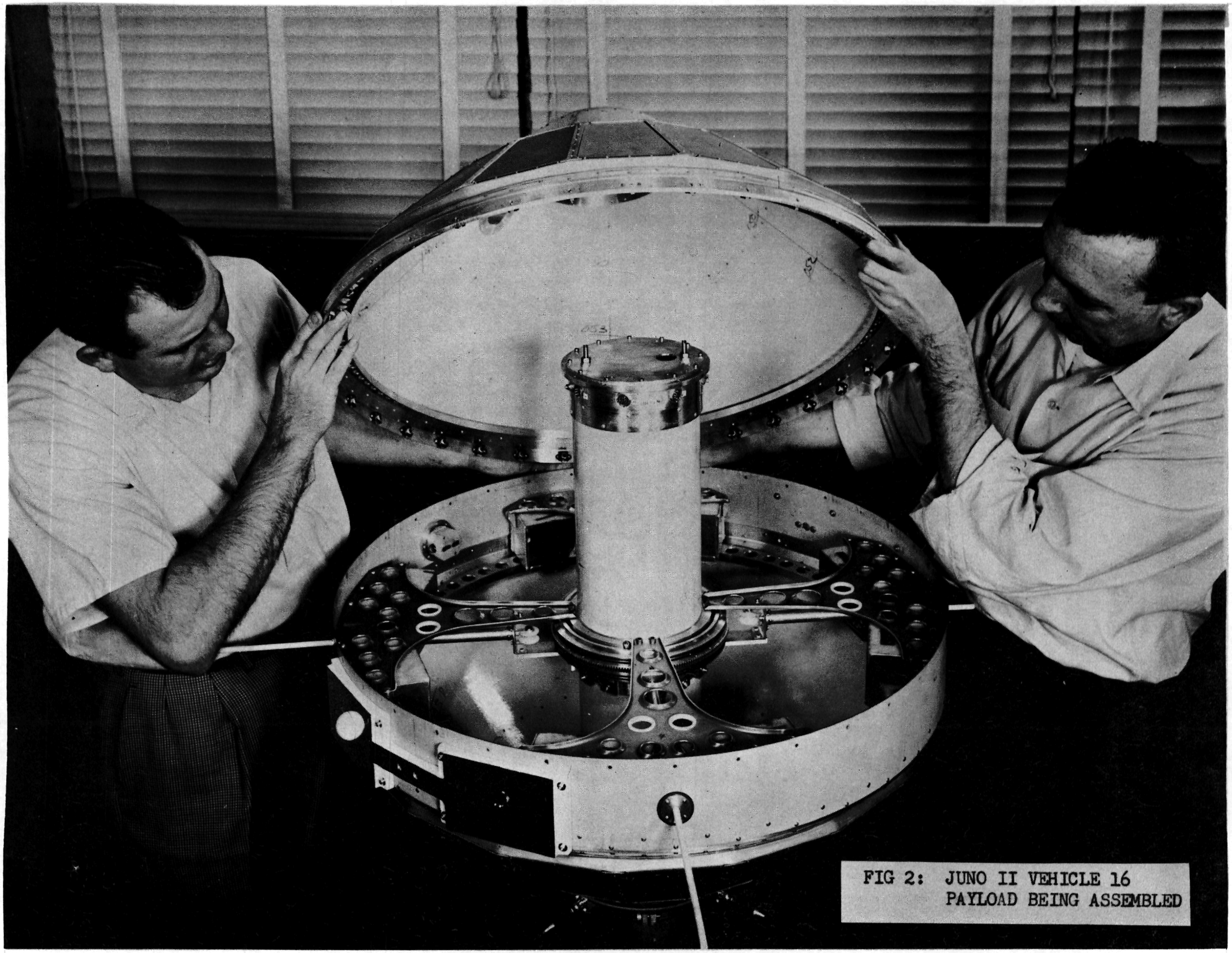
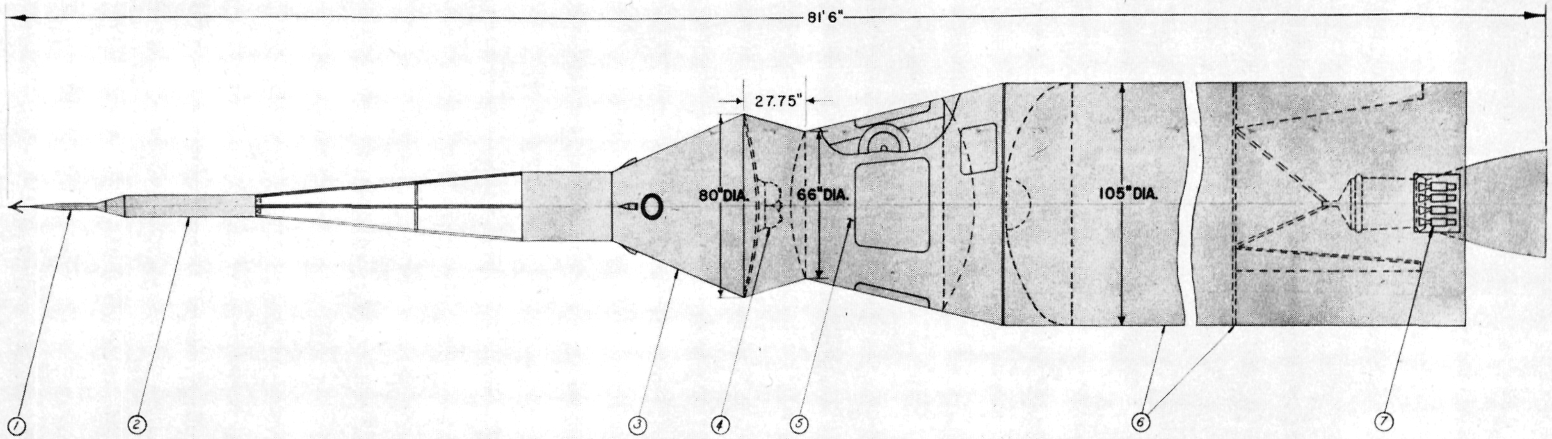


FIG 2: JUNO II VEHICLE 16
PAYLOAD BEING ASSEMBLED

# NASA CAPSULE ON JUPITER




| | |
|---|---|
| ① | ANGLE OF ATTACK METER |
| ② | ESCAPE ROCKET |
| ③ | NASA MANNED CAPSULE |
| ④ | CAPSULE RETRO ROCKET |
| ⑤ | INSTRUMENT COMPARTMENT |
| ⑥ | JUPITER IOC BOOSTER |
| ⑦ | SEPARATION RETRO ROCKETS |

FIG 3

NASA CAPSULE ON JUPITER

FILE NO. 697, 8 DEC 58

# ARMY ROCKET AND GUIDED MISSILE AGENCY

## PROGRESS REPORT ON NASA PROGRAMS

## ARGMA PROGRESS REPORT ON NASA PROGRAMS

I. Order # L55-931

Negotiations between Army Rocket and Guided Missile Agency and Thiokol Chemical Corporation were completed and Contract DA-01-021-506-ORD-698, Modification #2, was signed in January 1959. A purchase order for six sets of metal parts was issued by Thiokol.

II. Order # C-2642

Negotiations between Army Rocket and Guided Missile Agency and Thiokol Chemical Corporation to modify Contract DA-01-021-506-ORD-698 are continuing. It is anticipated that Modification #3 will be signed for the delivery of four XM-33 nozzles in the next three weeks.

III. Order # S-1013

Negotiations between Army Rocket and Guided Missile Agency and Thiokol are continuing; this work will be added along with the nozzle procurement as a part of Modification #3 to Contract Ord 698.

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